

DISTRIBUTION OF PRECIPITATION IN NORTH GERMANY.¹

By GUSTAV HELLMANN.

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The region considered is, roughly, that part of Germany lying north of latitude 50° N. Charts and data showing monthly and yearly averages based on 20 years' observations are published elsewhere, and the general results are discussed in this paper. Two tables are at present devoted to yearly averages, the one giving this information for individual provinces and the other showing the percentage area of each province which receives an annual rainfall between given limits. Posen is the driest (509 mm.), 42.4 per cent of the area receiving less than 500 mm., 57.1 per cent between 500 mm. and 600 mm., and 0.5 per cent between 600 mm. and 700 mm. The wettest is Westphalia (807 mm.), 50.4 per cent receiving between 700 mm. and 800 mm., while, quoting extremes, 1.1 per cent receives between 500 mm. and 600 mm., and 1.1 per cent between 1200 mm. and 1400 mm.

Monthly averages are expressed as percentages of the yearly sum, and three types of yearly distribution are recognized, according to the position of the maxima; (1) a single maximum in a particular month, (2) one or more secondary maxima, (3) a transition type in which a month adjacent to a maximum is almost as high itself. A map shows the distribution of these types, the salient features being that type (1) with a July maximum is by far the most extensive and that there is a general transition from a June maximum in the south to an October maximum in the north, September being passed over without showing as a maximum in any district. The driest month is March in East Prussia, February in the central regions and April in the west. The distribution of the amplitude, expressed as a percentage of the yearly sum, is illustrated by a map which shows a decrease from 12.5 per cent in the east to 3.5 per cent in the west, with a tendency for areas of maximum on the lee side of mountains. There is a rapid decrease with altitude in mountain districts.—*M. A. G.*

EARLY RECORDS OF TROPICAL HURRICANES ON THE TEXAS COAST IN THE VICINITY OF GALVESTON.²

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By REX D. FRAZIER.

[Houston, Tex., March 21, 1916.]

NOTE.—The following account of the hurricanes which visited the Texas coast in the vicinity of Galveston in early times is excerpted from a report rendered by Mr. Frazier to the Galveston-Houston Electric Railway Co. The record is here carried up to 1876, which is the date at which Dr. Oliver L. Fassig's record (*Weather Bureau Bulletin X. "Hurricanes of the West Indies"*) begins. While Mr. Frazier has only considered storms affecting Galveston and vicinity, Dr. Fassig has treated the subject with respect to the frequency, the tracks of the storms, and their annual distribution; hence the records are not comparable. However, aside from its historical interest, this record of early storms may have uses of a scientific character. Mr. Frazier's courtesy in submitting his entire report to the Weather Bureau is acknowledged.—EDITOR.

Tradition tells of great gales that have swept the Texas coast, inundating it to a great extent and uprooting trees, casting ships far inland, and changing coast lines. Historical reference is made to gales that wrecked the ships of the early explorers. Probably the first is in the narrative of Alver Nunez, a Spanish explorer, who, with 48 companions, the survivors of a party of 240, was cast ashore during a gale in November, 1527. They landed on an island called Malhado, which, according to historians, was in all probability Galveston Island. La Salle in his wanderings along the Texas coast searching for the mouth of the Mississippi river encountered severe gales.

According to the Spanish chroniclers, a severe gale on September 4, 1766, destroyed a mission on the shore of Galveston Bay and caused a high tide which inundated the land.

Several years ago the writer was told that the bleaching hulk of a wrecked vessel stood 40 miles inland on the prairie between Matagorda and Copano Bays. This vessel had been there within the memory of the earliest settlers. About eight or nine years ago the rotting hulk of an old vessel was uncovered at a point about 25 miles west of Houston. This find was at least 40 miles from the nearest salt water, but as it was only 4 miles from the channel of the Brazos River very likely it had been carried overland and buried during one of the periodical floods of that stream. The oldest resident in that vicinity did not know when the vessel had been wrecked, so

it evidently occurred in the early part of the past century or possibly earlier.

From the best authorities it is learned that up to the year 1816 Galveston Island was uninhabited, and it is probable that the only human beings regularly visiting the island were the Carankawa (also spelled "Carancahau") Indians. This was a tribe of stalwart savages, having the reputation of being cannibals, who hunted along the Texas coast and crossed to Galveston by a series of shoals about 15 miles west of the city. This string of shoals or reefs still bears their name.

In the narrative of Col. Warren D. C. Hall, printed in 1859, Galveston Island in 1816 is mentioned as Snake Island, or Isle de Calebras, as it was called by the Mexicans and Indians, and was not generally known, if at all, as Galveston. However, all the islands along the Texas coast were called Isles de Calebras in consequence of the number of rattlesnakes to be found in the driftwood and sand hills common to all of the islands next to the Gulf shore. According to Col. Hall, the island in 1816 was composed mainly of marsh, with an occasional ridge or elevation of 2 or 3 feet, and the whole surface, with the exception of the bays and bayous, was covered with a luxuriant growth of grass.

The main island was separated from a smaller one to the eastward by a pass from the Gulf 5 or 6 feet deep, and the eastern island was known as Little Campeachy. Col. Hall fails to mention that Galveston Island was called Campeachy, which is mentioned by different historians. According to an issue of the *Galveston News* under date of Tuesday, June 4, 1869, Don Luis Aury visited Galveston Island on May 10, 1817, and found the pirate Lafitte, driven from Baratania, in full possession of the island. Aury mentions that the island was called Campeachy.

At that time Pelican Island was merely a narrow piece of marsh on which it was impossible to walk dry-footed, except upon a small spot about 100 feet in length. The marsh, covered with sea grass growing in the mud, was covered with water at high tide and was not visible at any distance. Col. Hall mentions that by 1820 the island had increased to a kind of shell bank, the east side of

¹*Preuss. Akad. Wiss.*, Berlin, 1919, 38: 980-990.²Cf. also Early Texas coast storms. *MO. WEATHER REV.*, Sept., 1919, 47: 641-642.

which had a few small bushes growing upon it. As this was after the hurricane of 1818, it is evident that this storm or some previous hurricane changed the contour and topography of the island. The writer has examined old charts of portions of the Texas coast he is familiar with. All were much different than at present. Islands and channels have appeared and disappeared during the past century; bays have changed their depths and bottom; and the general shape of the shore has greatly changed. Without a doubt hurricanes have been the cause. In a previous report mention is made of the loss of several blocks of land off the east end of the city of Galveston during a hurricane. In the 1900 hurricane Galveston lost from one-half to two blocks of land fronting the entire Gulf shore. In the August, 1915, hurricane, the beach outside of the sea-wall disappeared, and on Bolivar peninsula the waters of the Gulf encroached to such an extent that the Gulf & Interstate Railway Co. was compelled to secure 20 miles of new right of way. The waters of the Gulf now cover the site where their tracks were located immediately before the hurricane.

Col. Hall also saw in 1820 what are now known as Deer Islands, west of the location of the causeway. Now they are of fair size, but he described them as not having an acre of dry land on the largest, and further mentioned that they were entirely covered with water during high tides. They were then known as Egg Islands, and there was not a bush or shrub on them.

Crossing Galveston Island to the sand hills in the western portion of the present city limits there was an almost continuous marsh, a large portion of which was subject to overflow at periods of high tide.

The first great gale that visited Galveston of which there is any authentic record was in 1818, when four of Lafitte's vessels were sunk or driven ashore. Without doubt this was a hurricane whose center passed over or near the island. In the following year Col. Hall mentions that he saw the wrecks of these vessels. One was lying near L'Allemande's fort, the highest point of the island, and another was ashore at Virginia Point, the apex of the adjacent mainland to the north.

Owing to the fact that there was no settlement on Galveston Island and only at intervals was it visited by hunting and camping parties, the next mention of a hurricane is in the year 1837. On October 6 several buildings in the course of construction were blown down and a number of vessels sunk or driven ashore, among them being the man of war *Brutus* and the privateer schooner *Tom Toby*.

The following account of this hurricane is from the *Telegraph and Texas Register* (the first paper printed in Houston), October 11, 1837:

The late accounts from the seaboard are of the most distressing character. A tremendous gale appears to have swept the whole line of the coast and destroyed an immense amount of property. It commenced on the 1st and increased in violence until the 6th. At Velasco four houses were blown down; the whole country for miles around inundated and all of the vessels in the harbor, consisting of the brig *Sam Houston*, and the schooners *De Kalb*, *Fannin*, *Texas*, and *Caldwell*, were driven ashore. The last named has since been got off and cleared on Sunday last for New Orleans. At Galveston the waters were driven in with such violence that they rose 6 or 7 feet higher than the ordinary spring tide. They inundated a large portion of the east end of the island and compelled soldiers of the garrison to desert their barracks and seek shelter on the elevated ground near the intended site of Galveston City.

The large new warehouse of Mr. McKinney and the new customhouse were completely destroyed and the goods scattered over the island. The brigs *Perseverance*, *Jane*, and *Elbe* (the latter a German vessel) were driven ashore and are complete wrecks; the *Phoenix* is also ashore, but slightly injured, and may be easily set afloat again. The schooners *Select*, *Henry*, *Star*, *Lady of the Lake*, and the prize schooner *Correo* are

ashore, some of them high and dry. The *Tom Boy* (privateer) is a wreck, and the *Brutus* (Texan naval schooner) is considerably damaged. The schooner *Helen* is the only vessel which has received no damage. So far as we have been able to learn only two individuals have perished. The history of this country contains no record of any hurricane that has equaled this, either in the violence of the storm or the extent of the destruction. There is a reason to believe that the destructive influence of this gale has extended gradually over the surface of the Gulf; we therefore apprehend that the next intelligence from the United States and from Mexico will be rife with accounts of disastrous shipwrecks. We sincerely trust that neither the calamities of enemy nor friend will equal our own.

The *Galveston News*, under date of June 4, 1839, states that the newly completed Tremont Hotel, built on the site of the present building and completed early in 1837, was blown down in the October hurricane of that year (1837). It was reconstructed and opened April 22, 1839.

As a matter of historical interest only, the brig *Elbe*, referred to above, was never repaired and hauled into water, but for many years served as Galveston's jail.

In October, 1842, Galveston was visited by a severe gale, the lowlands being flooded and considerable damage done to buildings and shipping.

The great September hurricane of 1854 did little damage to Galveston. The water came up on the floors of some of the stores on the strand, and the little steamer *Nick Hill* was wrecked.

Mr. Charles Trube, who has resided in Galveston for the past 66 years, told the writer several days ago that he distinctly remembers the hurricane of 1854. Confirming statements of early writers, he stated that one peculiar feature of the gale has been overlooked. Previous to the advent of the hurricane, Galveston was in the throes of a severe yellow fever epidemic. When the hurricane blew out the yellow fever went with it, those being ill recovering from the scourge and no new cases were reported.

On the night of October 2 and 3, 1867, Galveston was visited by a severe hurricane, which did much damage to the city and shipping. Quite a number of vessels were wrecked and the Galveston, Houston & Henderson Railway bridge across Galveston Bay was destroyed. A number of lives were lost, and the damage was estimated at a million dollars. The cemetery was inundated to such an extent that there could be no interments for 30 hours. This is the first mention of any bridge across Galveston Bay being destroyed.

Mr. Ousley states that on the 9th of June, 1871, Galveston was visited by an easterly gale, which reached its height at midnight, breaking the following morning. Considerable damage was sustained in the city and among the shipping, but no loss of life was reported.

Referring to pages 10 and 11 of the previous report, under dates of June 8 to 10, 1871, the presumption that the weather records on those dates indicated the proximity of a hurricane is verified.

On the 2d and 3d of October, 1871, Galveston was visited by a severe easterly blow, and the water flooded almost the entire city. The steamer *C. R. Hall* foundered in the upper bay and all hands were lost with the exception of one man. Several other vessels were wrecked.

Evidently the Galveston weather office overlooked this blow, as no mention was made of it in the early records.

Mr. Ousley has additional information regarding the hurricane of September 14-17, 1875, pages 11 and 12, in the previous report. He states that many houses in the city were wrecked and shipping in port was greatly damaged. "There were a number of men at Fort Point in Government employ," he states, "and their quarters were washed away and 13 of them drowned. Dr. Geo.

W. Peete, quarantine officer at the point, and his nephew were swept away and lost, and several persons in the city were killed. Along the upper bay there were a number of lives lost. Up to this date this had been the most destructive storm in the history of the Texas coast."

From this date to the present year the previous report contains all available data.

You will note big gaps in this record during the earlier part of the last century. While the island was occupied as early as 1817, it was abandoned in 1822, and only hunting and fishing and treasure-seeking parties visited the island for a number of years. As the entire Texas coast region was a wilderness, it can hardly be expected that hurricanes or storms should be chronicled during this period. Hurricanes may have occurred and the island and adjacent mainland may have been tide swept many times during that period without the phenomena being noticed, or at least being recorded.

Following the storm of August 15-17, 1915, Mr. Ben C. Stuart, of Beaumont, Tex., wrote a letter to Dr. B. Bunnemeyer, section director of the United States Weather Bureau, Houston, containing a list of hurricanes that have visited the Texas coast from the dawn of history to 1867. As this letter is very interesting it is given in full herewith:

While severe storms have swept the coast of Texas long before the dawn of history, the first authentic record we have dates from September 4, 1766, when, according to the Spanish chroniclers, a severe gale visited Galveston Bay. An Indian mission and presidio, called San Augustus de Ahumado, had been located in what is now Chambers County, and by investigation thought to have been situated on or near Lake Charlotte, which connects with the Trinity River just north of the present settlement of Wallisville. The wind greatly damaged the mission buildings, and the water from the bay and river submerged the land, which was only a few feet (probably 6 or 8) above ordinary tide. The disaster resulted in the abandonment of the mission. Lake Charlotte is 6 miles from the mouth of the Trinity River, and more than 50 miles from the Gulf of Mexico. The same spot was submerged during the hurricane of August 15-17, 1915.

As the coast of Texas was uninhabited for many years, save by roving bands of savages—the Opelousas near Sabine Lake and along Bolivar peninsula and the Carancahuas and Cokes from Galveston Island as far west as Aransas and probably to the vicinity of the Rio Grande—there is no record of hurricanes until the occupation of the island by Lafitte in 1817, and our information regarding it comes from statements made by James Campbell, who was in the service of Lafitte, and Col. Warren D. C. Hall, an officer under Gen. James Long, who was operating against the Spaniards and who visited Galveston Island to attempt to enlist Lafitte in the enterprise, but without success. According to them the island was visited by a severe hurricane, the wind being from the east and northeast and veering to the northwest. The exact date of the storm has not been preserved, but it was in September or October, 1818. The entire island was submerged with the exception of a small spot on the East end near the present site of the State Medical College. Lafitte's huts on shore were badly damaged and several of the vessels cast ashore or sunk. There is no record of the number of lives lost, if any.

From 1820 to 1836 there was no settlement on Galveston Island, although the Mexicans had built a small frame structure there in 1831 for a custom house, but it does not appear to have been used for any length of time. In 1821 settlers began to arrive, passing up the bay and located in the succeeding years at Harrisburg, Anahuac, and other points, but in none of the records of the period between 1821 and 1836 is there mention of any destructive hurricane on the Texas coast. This does not signify that there was none, but as all of the settlements, with very few exceptions, were inland they would not have felt its effect to the same extent as the island.

The year 1837 witnessed the beginning of Galveston, and by October several buildings were under construction. Immigrants were coming in, and there were 20 vessels in the harbor. There were no wharves, and the Mexican custom house was the only building on the island, the population being sheltered in tents or sod huts. On the 1st of October an easterly gale began blowing and continued with more or less intensity until the 6th, causing a very high tide and submerging most of the island. The wind then suddenly veered to the northwest and swept the waters of the bay down and across the island.

At this point Mr. Stuart has inserted the extract from the *Telegraph and Texas Register* of October 11, that year,

giving an account of the hurricane. This is given in the forepart of this report. Continuing, Mr. Stuart says:

Col. Amasa Turner, who was present, wrote as follows: "There were about 30 vessels in Galveston Harbor when the great storm commenced on October 1, 1837. It began with a wind from the southeast and held to that quarter for three days; then it veered a little to the east and so continued until the sixth day, filling the bay very full and making a 4-foot rise at Houston. On the evening of the 6th the wind veered to the northeast and blew very strong. The schooner, *Tom Toby*, a privateer, parted her cable and went ashore at Virginia Point. About sunset the wind, veering all the time to the north and, if possible, increasing, brought the large volume of water from the bay onto the island with such force and violence as to sweep everything in its course. On land every house, camp, sod house, and inhabited structure was swept away except the old Mexican custom house. Only one of the vessels held its moorings."

On the 5th of October, 1842, another hurricane visited Galveston, but the wind was not so high as in 1837, nor the tide, although much of the town (then lower than at present) was flooded, and considerable damage to goods was sustained. The wooden Episcopal Church, on the southeast corner of Tremont and Winnie Streets, was blown from its blocks and badly wrecked. A number of other buildings were damaged and several small structures were demolished. No loss of life in the town was reported.

The great gale of September 16-19, 1854, which swept the Texas coast, did not inflict much damage at Galveston, its greatest force being felt to the westward. Of its effect at Galveston the *Civilian and Gazette* of September 19, said:

"An easterly gale began to blow last Saturday and has continued almost without interruption to the present time. The wind has not been severe, but, being from the quarter which always produces the highest tides, the waters of the Gulf and bay have been higher than we recollect since 1842. The floors of a number of stores on the Strand were overflowed during Sunday night, and considerable damage was done to such articles as were deposited on the floor. The little steamer *Nick Hill* was lost off Dollar Point."

The greatest force of this hurricane was felt at the town of Matagorda, to the westward of Galveston. Col. J. D. Parks, then residing there, but afterward at Temple, said: "It left a trail of disaster to be recorded in history. Hardly a house was left standing in the town site or vicinity." Another eyewitness says: "The storm at Matagorda was September 18, 1854. The water from the bay did not come over the town. Two people were killed. The steamer *Kate Ward* and crew were lost in Matagorda bay—from report it was said at Dog Island."

It is the writer's opinion that this was the hurricane that destroyed the settlement at Saluria, which was situated either on Bayucos island, lying between Espiritu Santo bay and Matagorda bay, or on an island that has merged with Matagorda island and before its merger was known as Saluria island. During the nine months the writer spent in that vicinity Bayucos island was called Saluria island by many. Other, some of them old residents in that section, stated that after the hurricane the channel separating Saluria and Matagorda islands disappeared. As various years were given in which the "big" hurricane occurred it is very likely that that section was affected by several of the storms that have been recorded on the Texas coast.

Continuing, Mr. Stuart says:

The great hurricane of August 10, 1856, was felt but little at Galveston, but L'Île Dernier, or Last Island, a summer resort on the Louisiana coast, was engulfed with the loss of many lives. The steamer *Nautilus* from Galveston for New Orleans, with 30 passengers, however, ran into the gale and foundered, all hands being lost except a negro man who clung to a bale of cotton and was cast ashore on the Louisiana coast.

In the latter part of September, 1865, a hurricane struck the town of Calcasieu on the West Louisiana coast. The place was inundated and some 8 or 10 persons perished. As there was neither telegraph nor rail communication to that place, the report was brought to Galveston by the master of a lumber schooner.

On Wednesday, October 2, 1867, a strong easterly gale commenced blowing at Galveston, which shifted to the northeast during the night and on the morning of the 3d had attained a velocity estimated between 60 and 70 miles an hour. There was no weather bureau, and, of course, the figures were only guesswork. During the morning of the 3d the waters of the Gulf and bay rose rapidly until much of the city was flooded. The water from the north side came nearly up to Church Street at its highest elevation, while from the Gulf side it reached nearly to Broadway. The cemeteries at Fortieth Street and Broadway were inundated, and all the lowland down the island was covered with

water. Much damage was done to buildings in the city and more than 30 were destroyed. The lower floors of the stores on the Strand and Mechanic Street were flooded and their contents badly damaged. The brig *Ocean Wave*, from Philadelphia, was cast ashore on the beach near the present site of Fort Crockett, and her captain drowned. The bark *Palace* and the brig *Egarita* in the harbor were driven ashore, as were a number of small craft, and the steamboats *Alice M.* and *Sunflower* were wrecked. The trestle of the Galveston, Houston & Henderson Railroad between Eagle Grove and Virginia Point was completely wrecked, and communication was kept up by means of a ferry boat until after it was rebuilt, which was not done for several months. There were three lives lost and the property damage was estimated at \$1,000,000, including that to the vessels. As previously stated, the gale began from the eastward on October 2d, the wind veering to the northeast during the night and continuing from that quarter until about 2.30 on the afternoon of the 3d, when it lulled temporarily, to veer from the northwest, from which point it blew strongly for a short time, the waters receding rapidly, and by 5 o'clock the sky was clear and the wind of only moderate velocity. This hurricane cut a channel 5 feet deep through the low sand flat east of Sixth Street from the bay to the Gulf, which remained open for only a few months. It also did much damage at the mouth of the Rio Grande and at Brownsville.

With reference to this last it is the writer's recollection that it was this hurricane that destroyed the towns of Bagdad and Clarksville, situated opposite each other at the mouth of the Rio Grande.

Some years ago, when in that section, the stories woven about their destruction were often told the writer. During the war between the States those towns sprung into prominence because of the cotton running that was being done through them. One being situated on Texas soil and the other on Mexican soil, made it comparatively easy for the State to get its cotton to foreign ports. Both towns were swept away shortly after the war and it must have been during the hurricane of 1867.

Between the dates of June 1 and June 4, 1871, evidently a hurricane passed in the vicinity of Galveston.

On June 1 the journal records that the barometer was falling with a light northeast wind, and on June 2 mention was made of an exceptionally heavy sea.

On June 3 the barometer at 7 a. m. was 29.61, and at 4 p. m. the wind attained a velocity of 38 miles from the east, shifting to northeast at 4.36 p. m., with a continued velocity of 28 miles per hour. The rainfall amounted to 3 inches, and on June 4 the barometer stood at 29.51 inches. This is practically the entire record for their period.

On June 8 of the same year there is another entry of the wind falling to 10 miles per hour and the barometer falling. On the following day there was a heavy sea with the barometer 29.53 and a maximum wind velocity of 49 miles per hour from the northeast at 4.30 p. m., which destroyed all weather instruments on the roof. The wind attained an estimated velocity of 60 miles per hour.

On June 10 the journal contained the meager entry, "Barometer rising." Without doubt this was a hurri-

cane that entered the coast close below Galveston or passed in the Gulf in the vicinity of the city.

On July 14, 1874, a waterspout was observed 1 mile off the south beach of the city, which passed inland and broke when it reached the sand. Another waterspout was reported out to sea at the same time.

On September 3, 1874, storm warnings were received at the Galveston office, and on September 5 an unusually high tide was recorded with the wind east, and the journal makes mention of the fact that the people were apprehensive of an overflow.

On September 6 the journal bears entry that there was considerable excitement in the city over the dread of an overflow from the unusually high tide that prevailed, but the danger passed with little damage to the city.

September 14, 1875, the barometer was reported falling with a brisk wind from the northeast.

September 15 the barometer continued falling rapidly with a wind northeast, which attained a velocity of 41 miles per hour at 9.30 p. m.

September 16 the barometer continued to fall and at 9:49 p. m. had fallen to 29.40. The wind continued from the northeast, with velocities varying from 33 to 36 miles per hour.

September 17 the barometer fell to 29.03 at 2 p. m., with a 40-mile wind, which blew away the anemometer and other weather instruments. A new anemometer was put up, which recorded a wind of 60 miles, when it was again blown away. The entire island was covered with water and the center of the hurricane evidently passed very near the city. During the day of the 17th the wind suddenly shifted to the southeast and south, and, according to old residents that were interviewed, the water from the bay swept away several blocks of land from the east end of the island.

The center of this hurricane passed below Galveston and did considerable damage to points on the lower coast. The town of Indianola, on Matagorda Bay, below Port Lavaca, was practically swept away. One hundred and seventy-six people were killed and three-fourths of the houses and buildings were washed away. The maximum wind registered at this point was 88 miles per hour when the weather observatory was destroyed and the observer killed. The estimated velocity was above 100 miles per hour. The damage in the vicinity of Indianola was estimated at more than \$1,000,000.

On October 19, 1876, a hurricane was reported in the Gulf just east of Galveston, moving in a westerly direction. Galveston had a 24-mile wind with a fair tide, but on the following day the hurricane recurved and passed eastward.